(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 731 620 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.09.1996 Bulletin 1996/37

(51) Int. Cl.6: H04Q 7/24, H04Q 7/38

(21) Application number: 96100138.5

(22) Date of filing: 08.01.1996

(84) Designated Contracting States:
DE ES FR GB IT SE

(30) Priority: 07.03.1995 GB 9504491

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(54) Handover in a mobile telecommunications network with ATM switch

(57) The invention relates to mobile telecommunication networks. In such networks mobile handover can lead to the connections in the fixed network infrastructure being non optimal, resulting in the wasteful use of network resources. However optimisation of the network can cause breaks in transmission with the consequent corruption of user data. The mobile telecommunication network makes use of asynchronous transfer mode transmission and switching and incorporates broadband switching nodes. The facilities incorporated into such broadband switching nodes are used to enable network optimisation without the corruption of user data. To achieve various network configurations between the broadband switching node and mobile network interface units, marker cells are inserted into the data stream. Marker cells detectors are provided and the switching configurations are carried out in accordance with the detected marker cells.

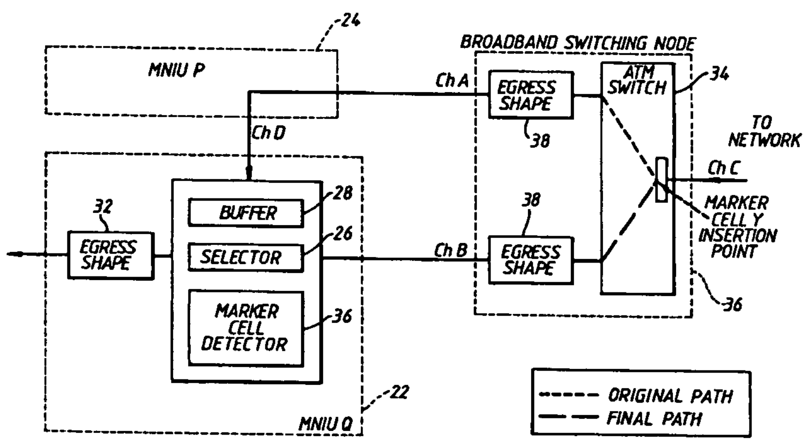

Fig. 3

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Description

The present invention relates to mobile telecommunications networks.

In such networks mobile handover can lead to the connections in the fixed network infrastructure being non optimum, resulting in the wasteful use of network resources but optimisation of the network can cause breaks in transmission with the consequent corruption of user data. Future mobile terminals may be supported by networks using Asynchronous Transfer Mode transmission and switching and will incorporate broadband switching nodes.

An aim of the present invention is to use the facilities incorporated into the broadband switching nodes to enable network optimisation without the corruption of user data.

According to the present invention there is provided a mobile telecommunications network comprising at least one mobile terminal arranged to communicate via a radio medium to at least a first and a second base station, said first base station being connected to a first mobile network interface unit which is connected to a switching node by way of a first channel, said second base station being connected to a second mobile network interface unit which is connected to the switching node by way of a second channel, said switching node being connected to the mobile telecommunications network by way of a third channel, said first and second network interface units being connected together by a fourth channel over which information is passed between said first and second mobile network interface units, characterised in that said switching node comprises an asynchronous transfer mode switching means, including marker cell insertion means and marker cell detection means, and each mobile network interface unit includes marker cell insertion means and marker cell detection means and selection means, and said marker cell detection and insertion means are used to control the operation of the asynchronous transfer mode switching means and selector means to enable different connections to be configured between said channels.

The invention will now be described with reference to the accompanying drawings in which,

FIGURE 1 shows a block diagram of part of a mobile telecommunications network,
FIGURE 2a shows a block diagram of a mobile transmitting via a base station to a first mobile network interface unit,
FIGURE 2b shows a block diagram of a mobile handing over to a base station on a second mobile network interface unit,
FIGURE 2c shows a block diagram of a network reconfigured to remove a communication path via the first mobile network interface unit,
FIGURE 3 shows a block diagram of a network for optimisation of a downlink,
FIGURE 4 shows a flow chart of the operation of a mobile network interface unit where optimisation of a downlink is being performed,
FIGURE 5 shows a block diagram of a network being optimised in respect of an uplink,
FIGURE 6 shows the optimisation protocol,
FIGURE 7 shows a block diagram of a number of mobile network interface units being connected to different broadband switching nodes, where one node has a common point, and,
FIGURE 8 shows a block diagram of a plurality of mobile network interface units being connected to different broadband switching nodes, and a third broadband switching node providing a common point.

Referring to Figure 1, typically the network part of the mobile system will consist of at least one mobile 8 arranged to communicate with a base station 2 connected to mobile network interface units (MNIUs) which in turn are connected to a switching node 6. An MNIU performs those specialised network functions required by a mobile system while the switching node performs call related functions as may be expected of a normal local exchange or end office. A particular MNIU is the point of interconnection between the mobile network and the fixed network for as long as a call is being handled by one of the base stations in its area of responsibility.

When a mobile hands over between base stations parented on different MNIUs there is a need to extend the connection within the fixed network. With reference to Figure 2a, the mobile 10 is assumed initially to be transmitting through a base station 12 parented on the MNIU P 14. When it hands over to a base station 16 parented on the MNIU Q 18 the principles of co-pending UK patent application numbers 9213373.5 and 9408122.1 can be used to forward the connection from the MNIU Q 18 to the MNIU P 14 as shown in Figure 2b. However this will result in the use of additional network resources which will be released if the path between the MNIU and the switching node 20 is optimised to have the configuration shown in Figure 2c. Unless special measures are taken optimisation will cause breaks in transmission which will result in corruption of the data passing over the connection.

Future mobile terminals may be supported by networks using Asynchronous Transfer Mode (ATM) transmission. Such networks subdivide the data to be transmitted over the network into small packets of data called cells. These consist of forty eight octets of user information and five octets of header information. The switching nodes within the ATM networks, here referred to as broadband switching nodes, can be expected to contain an ATM switch with a cell broadcast facility and associated peripheral devices to perform egress shaping. Egress shaping is a means of regulating the flow of traffic and uses buffering as described in co-pending UK

patent application number 9405788.2 and German patent application number 931 208 28.4.

The following description applies to optimisation of a single connection, but it will be appreciated that the invention may be applied to multiple connections.

The operation of optimisation of the downlink is as shown with respect to Figure 3. Initially downlink information from the network is routed to the MNIU Q 22 via the MNIU P 24 using channels A and D and only the switch connection C to A is present. When optimisation is initiated, the MNIU Q 22 inserts a selector 26 in the connection. This can be done without losing data since the MNIU Q 22 can monitor cells and do this between cells. The broadcast facility of the ATM switch is used to make a unidirectional connection from channel C to channel B in parallel with the connection between channel C and channel A, thus causing information to be sent to the MNIU Q 22 as well as via the MNIU P 24. The selector 26 at the MNIU Q 22 continues to send the information stream arriving on channel D to the base station. The MNIU Q 22 includes a buffer 28, a marker cell detector 30, and an egress shaping circuit 32.

The ATM switch 34 contained in the broadband switching node 36 is then caused to insert a Marker Cell (Y) simultaneously into both paths across the switch, this could be a special Resource Management cell, and these will both arrive at the MNIU Q 22 in due course. However the delays through the broadband switching node 36 can vary significantly especially where egress shaping circuits 32 are used and the difference in the path delays between the broadband switching node 36 and the two MNIUs 22, 24 can also be large. Thus it cannot be determined in advance which marker cell will arrive first. To prevent data loss or repetition, the following algorithm can be used at the selector 26 as shown with reference to Figure 4.

If the marker cell arrives over channel D first, transmission to the base station is stopped until the marker cell transmitted over channel B arrives. Transmission is then restarted using data arriving over channel B.

If the marker cell over channel B arrives first, the data transmission path is not changed and data via channel D continues to be sent to the base station. However data arriving over channel B is buffered at the MNIU Q until the marker cell arrives on channel D whereupon data from channel D is no longer sent to the base station. Instead, the buffered data is transmitted followed by data arriving over channel B.

The path length will usually shorten during optimisation resulting in an effective burst of user data. Also, downlink data can be buffered at the MNIU. To stop these factors causing the data rate over the air interface to exceed the allocated capacity or the rate expected by the user terminal, some egress shaping is required at the MNIU, in the form of an egress shaping circuit 32.

Following optimisation, the connection between C and A is released.

Considering now, optimisation of the uplink, with reference to Figure 5, initially the connection through the broadband switching node 40 is between channels A and C. When optimisation is initiated the MNIU Q 44 stops sending user data towards the broadband switching node 40 and inserts a Marker Cell (X) into the path using the ATM switch 42. It buffers subsequent data arriving from the base station (the buffer can be inserted during an inter cell interval thus avoiding cell loss).

When the marker cell reaches channel C at the ATM switch it causes the switch to insert a second Marker Cell (Y) in the return path, as described with reference to the downlink, and is the same marker cell as used for downlink optimisation. When the first copy of this marker cell arrives at the MNIU Q 44 it is certain that the broadband switching node input buffers and any buffers internal to the ATM switch have been flushed, and that changing the switch paths cannot cause data loss. The egress shaping circuit 46 for channel C is unaffected and any cells buffered here are not lost. The ATM switch paths can thus be re-configured safely and channel C is connected to channel B rather than channel A. The MNIU Q 44 then restarts transmission over channel B and uplink optimisation is complete.

It is assumed that egress shaping will be provided in the broadband switching node thus any burstiness in data resulting from the optimisation can be smoothed out there. The connection between channel B and channel D is made via a cell router 50, contained in the MNIU 44. A buffer 48 is so provided prior to the cell router 50 and is used as a marker cell X insertion point.

The optimisation protocol will now be discussed. Referring to Figure 6, the MNIU Q starts off by requesting details of the connection path from the MNIU P and from the broadband switching node. The MNIU Q then requests the broadband switching node to set up a monitor path from channel C to channel B. The MNIU Q then inserts a Marker Cell (X) into channel D which causes the broadband switching node to insert a Marker Cell (Y) into channels A and B.

On receipt of the first Marker Cell (Y), the MNIU Q requests the broadband switching node to make the connection between channels B and C bi-directional. It is assumed that this would automatically cause the path between C and A to become unidirectional and be treated as a leaf of a multicast tree. When the MNIU Q knows the switch has re-configured it starts transmitting the buffered data on channel B followed by the data received from the base station.

Following the receipt of both the Marker Cells (Y), MNIU Q will change over to transmitting cells received on channel B to the base station in accordance with the algorithm given in Figure 4. Whereupon it causes the broadband switching node to transfer control from channel A to channel B and requests the path between channels A and C to be cleared. Finally MNIU P is instructed to clear the connection between channels D and A.

It will be appreciated by those skilled in the various alternative embodiments are possible which fall within the scope of the present invention for example, where base stations are connected directly to a broadband

switching node, the principles of the above can be used to prevent data loss during mobile handover. The base station or mobile terminal would then perform the functions executed by the MNIU in the above.

When the MNIUs P and Q are attached to different broadband switching nodes as shown in Figures 7 and 8 the same principles can be applied. The protocols of Figure 6 would operate between the MNIUs and the node interfacing to a circuit connected on line C (ie the point where the two paths diverge). Signalling information and user data would be passed transparently between the MNIUs and this node (ie transparently through broadband node M in Figure 7 and nodes L and M in Figure 8. However there would be a modification to the early part of the protocol to enable the connection trace to be extended.

Typically, the circuit connected to line C could be the point where the fixed network connection first interfaces to a broadband switching node within the mobile network but it could be the broadband switching node closest to the remote user terminal.

Claims

1. A mobile telecommunications network comprising at least one mobile terminal arranged to communicate via a radio medium to at least a first and a second base station, said first base station being connected to a first mobile network interface unit which is connected to a switching node by way of a first channel, said second base station being connected to a second mobile network interface unit which is connected to the switching node by way of a second channel, said switching node being connected to the mobile telecommunications network by way of a third channel, said first and second network interface units being connected together by a fourth channel over which information is passed between said first and second mobile network interface units, characterised in that said switching node comprises an asynchronous transfer mode switching means, including marker cell insertion means and marker cell detection means, and each mobile network interface unit includes marker cell insertion means and marker cell detection means and selection means, and said marker cell detection and insertion means are used to control the operation of the asynchronous transfer mode switching means and selector means to enable different connections to be configured between said channels.

2. A mobile telecommunications network as claimed in claim 1, wherein, in operation, one of said mobile network interface units is arranged to request details of a connection path from the other mobile network interface unit and from the switching node, said one mobile network interface unit is arranged to request the switching node to set up a monitor path from said third channel to said second channel, said one mobile network interface unit is arranged to insert a marker cell into said fourth channel and causes said switching node to insert a marker cell in to the first and second channels, and on receipt of this marker cell, said one mobile network interface unit is arranged to request the switching node to make the connection between the second and third channels bi-directional, and when said one mobile network interface unit is aware that said connection is configured it starts transmitting data on the second channel followed by data received from said base station, and upon receipt of both said marker cells said one mobile network interface unit is caused to transmit cells received on said second channel to said base station, whereupon said switching node is caused to transfer control from said first channel to said second channel and requests the path between said first and said third channels to be cleared, and said other mobile network interface unit is instructed to clear the connection between said fourth and said first channels.

3. A mobile telecommunications network as claimed in claim 1 or claim 2, wherein each mobile network interface unit is connected to a different broadband switching node.

4. A mobile telecommunications network as claimed in any preceding claim, wherein each mobile network interface unit includes a cell router which directs cells via the second or the fourth channel.

5. A mobile telecommunications network as claimed in claim 4, wherein each mobile network interface unit includes buffer means connected to the input of said cell router, at which point marker cells are inserted into the data stream.

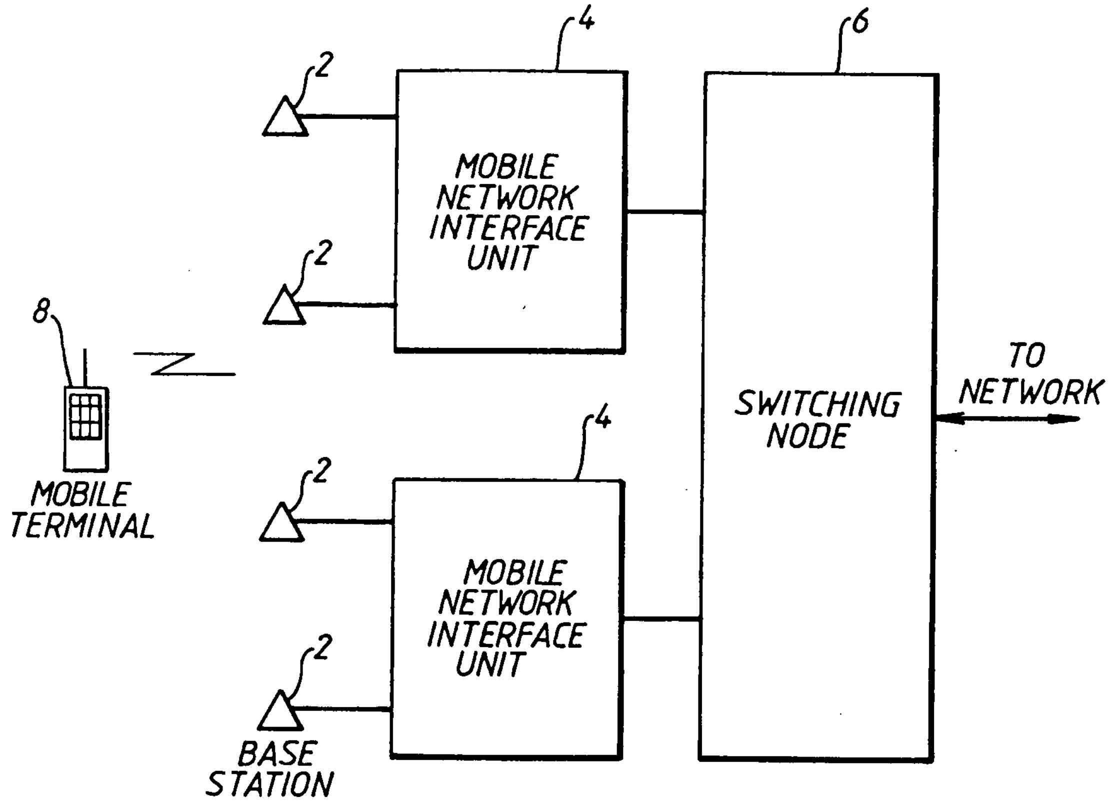
2
2
2
2
4
4
6
8
MOBILE NETWORK INTERFACE UNIT
MOBILE NETWORK INTERFACE UNIT
SWITCHING NODE
TO NETWORK
MOBILE TERMINAL
BASE STATION

Fig. 1

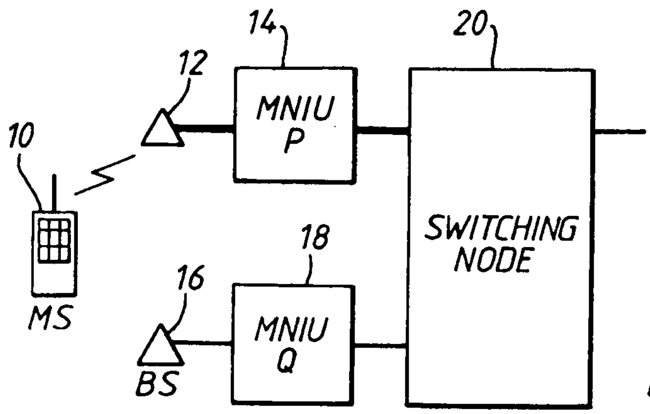

Fig. 2a

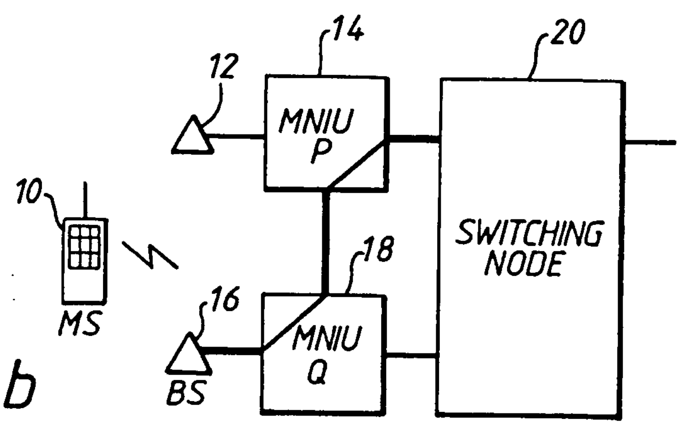

Fig.2b

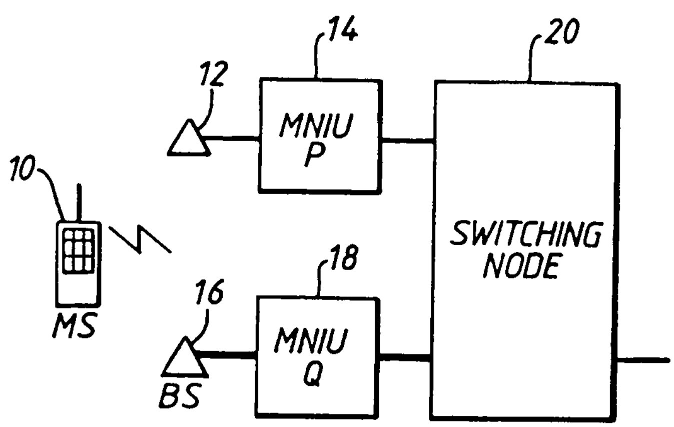

Fig. 2c

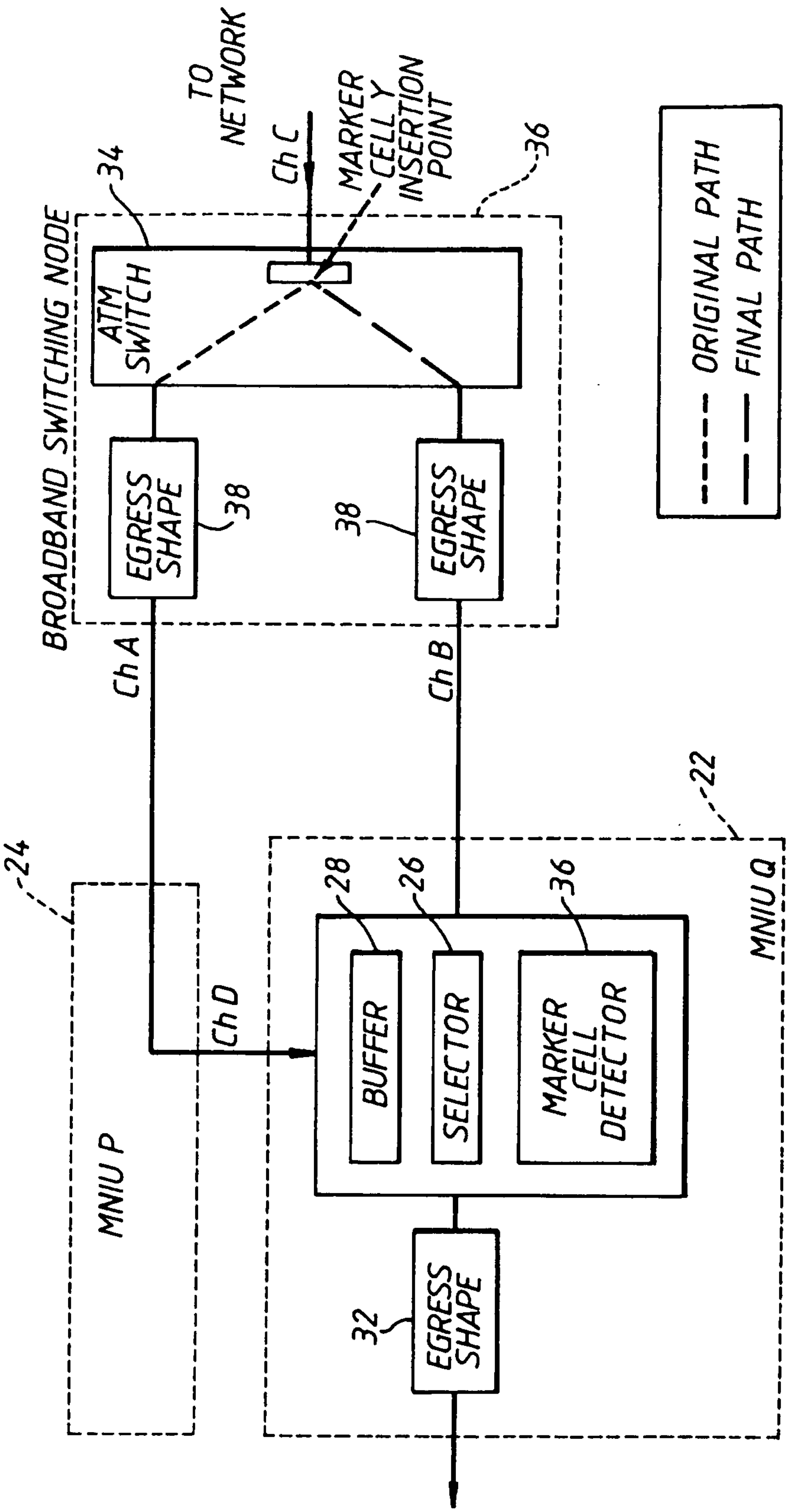
TO NETWORK
Ch C
MARKER CELL Y INSERTION POINT
36
34
BROADBAND SWITCHING NODE
ATM SWITCH
EGRESS SHAPE
38
38
EGRESS SHAPE
Ch A
Ch B
ORIGINAL PATH
FINAL PATH
24
22
28
26
36
MNIU Q
Ch D
BUFFER
SELECTOR
MARKER CELL DETECTOR
MNIU P
32
EGRESS SHAPE

Fig. 3

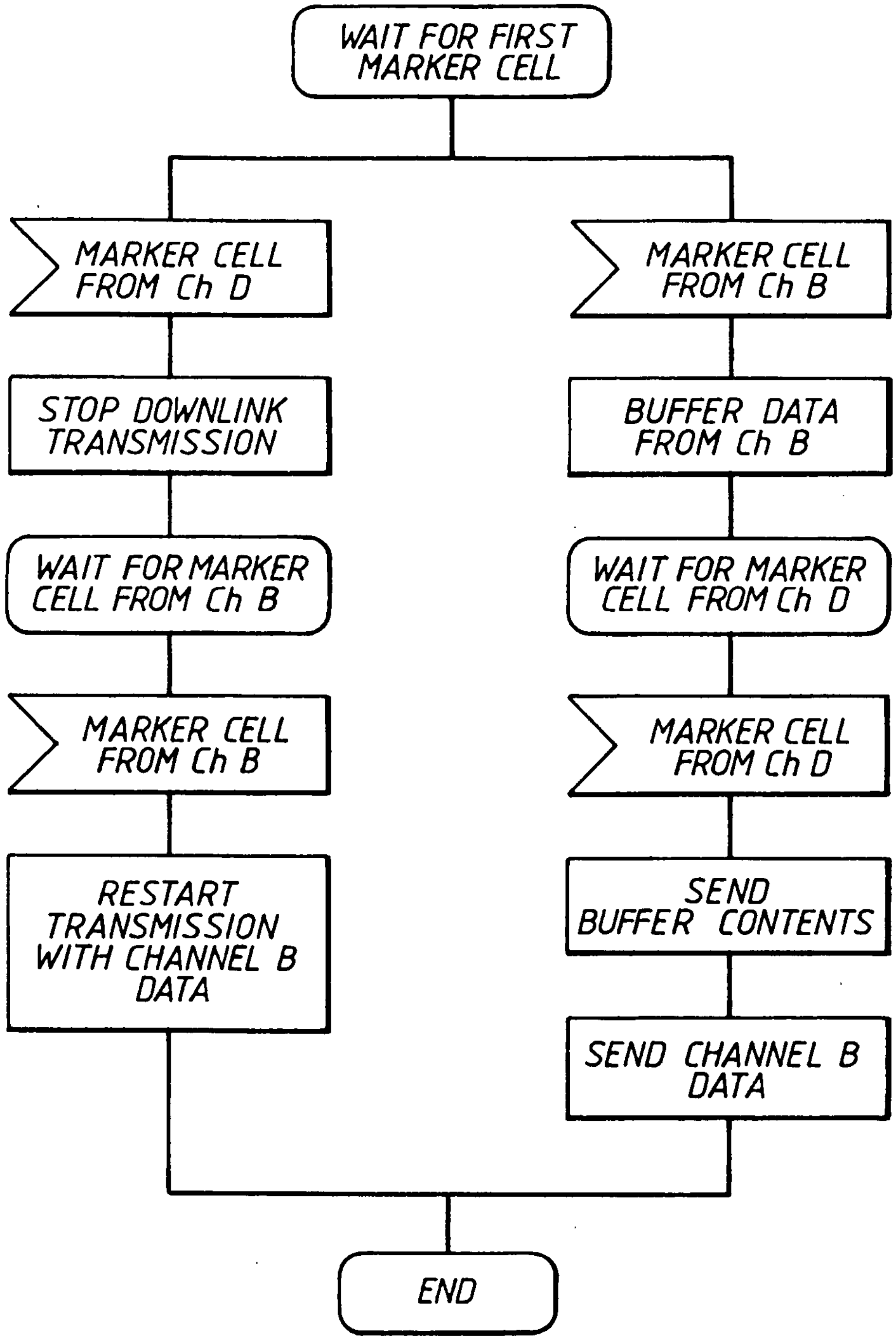
WAIT FOR FIRST MARKER CELL
MARKER CELL FROM Ch D
STOP DOWNLINK TRANSMISSION
WAIT FOR MARKER CELL FROM Ch B
MARKER CELL FROM Ch B
RESTART TRANSMISSION WITH CHANNEL B DATA
MARKER CELL FROM Ch B
BUFFER DATA FROM Ch B
WAIT FOR MARKER CELL FROM Ch D
MARKER CELL FROM Ch D
SEND BUFFER CONTENTS
SEND CHANNEL B DATA
END

Fig. 4

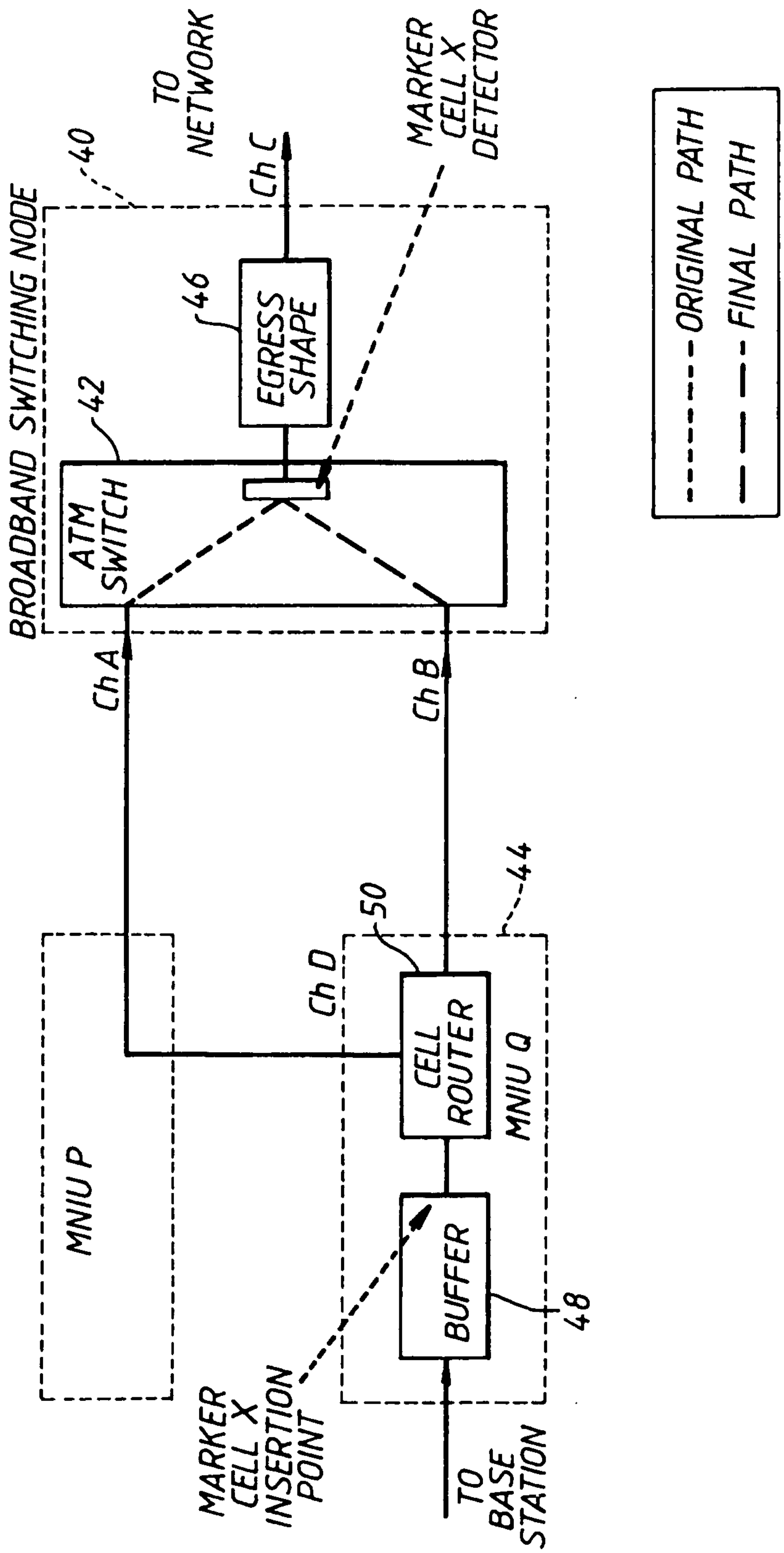
TO NETWORK
MARKER CELL X DETECTOR
40
Ch C
BROADBAND SWITCHING NODE
46
EGRESS SHAPE
42
ATM SWITCH
Ch A
Ch B
ORIGINAL PATH
FINAL PATH
44
50
Ch D
MNIU P
CELL ROUTER
MNIU Q
BUFFER
48
MARKER CELL X INSERTION POINT
TO BASE STATION

Fig. 5

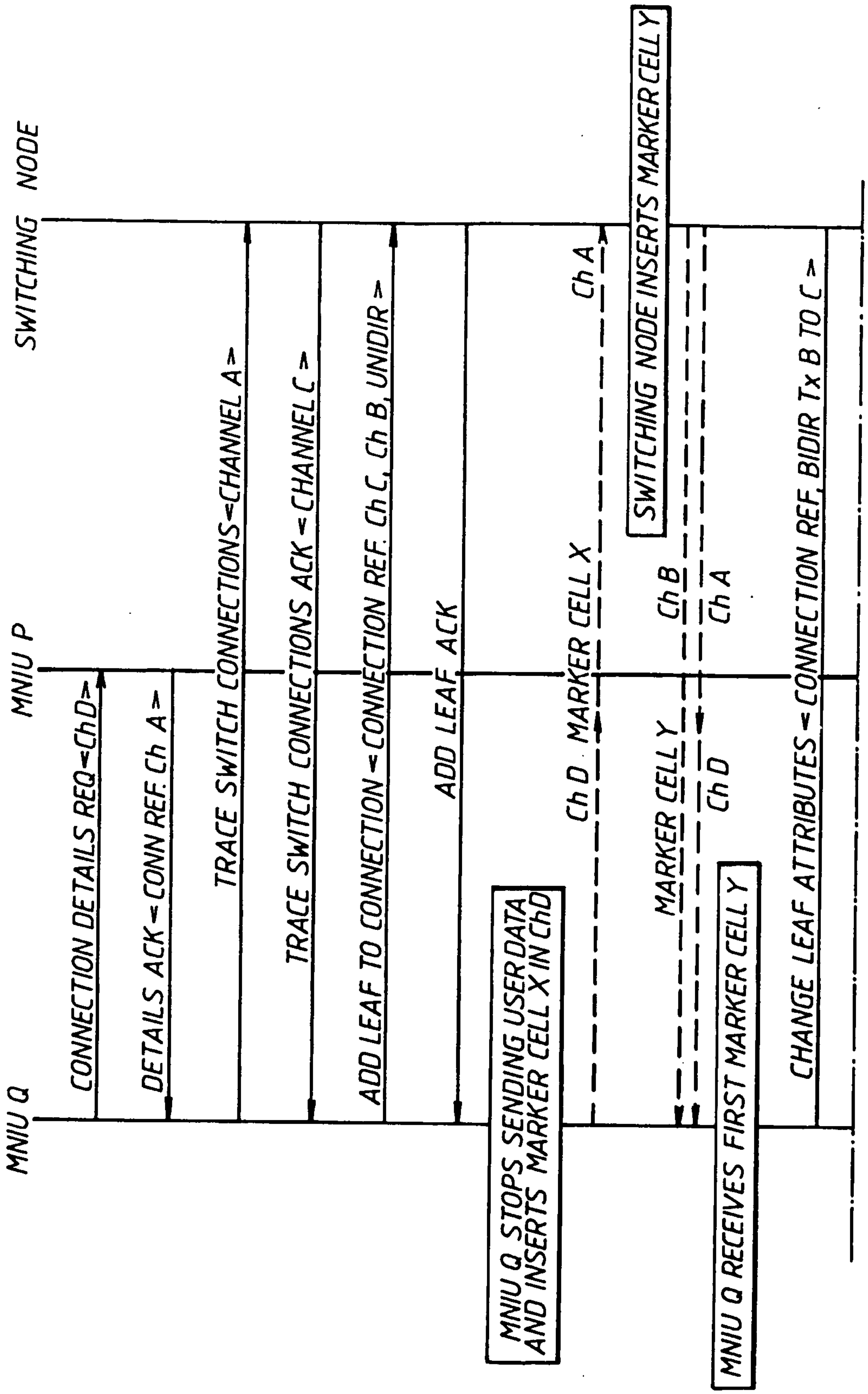
MNIU Q
MNIU P
SWITCHING NODE
CONNECTION DETAILS REQ <ChD>
DETAILS ACK <CONN REF. Ch A>
TRACE SWITCH CONNECTIONS <CHANNEL A>
TRACE SWITCH CONNECTIONS ACK <CHANNEL C>
ADD LEAF TO CONNECTION <CONNECTION REF. Ch C, Ch B, UNIDIR>
ADD LEAF ACK
MNIU Q STOPS SENDING USER DATA AND INSERTS MARKER CELL X IN ChD
Ch D
MARKER CELL X
Ch A
SWITCHING NODE INSERTS MARKER CELL Y
MARKER CELL Y
Ch B
Ch D
Ch A
MNIU Q RECEIVES FIRST MARKER CELL Y
CHANGE LEAF ATTRIBUTES <CONNECTION REF, BIDIR Tx B TO C>

Fig. 6

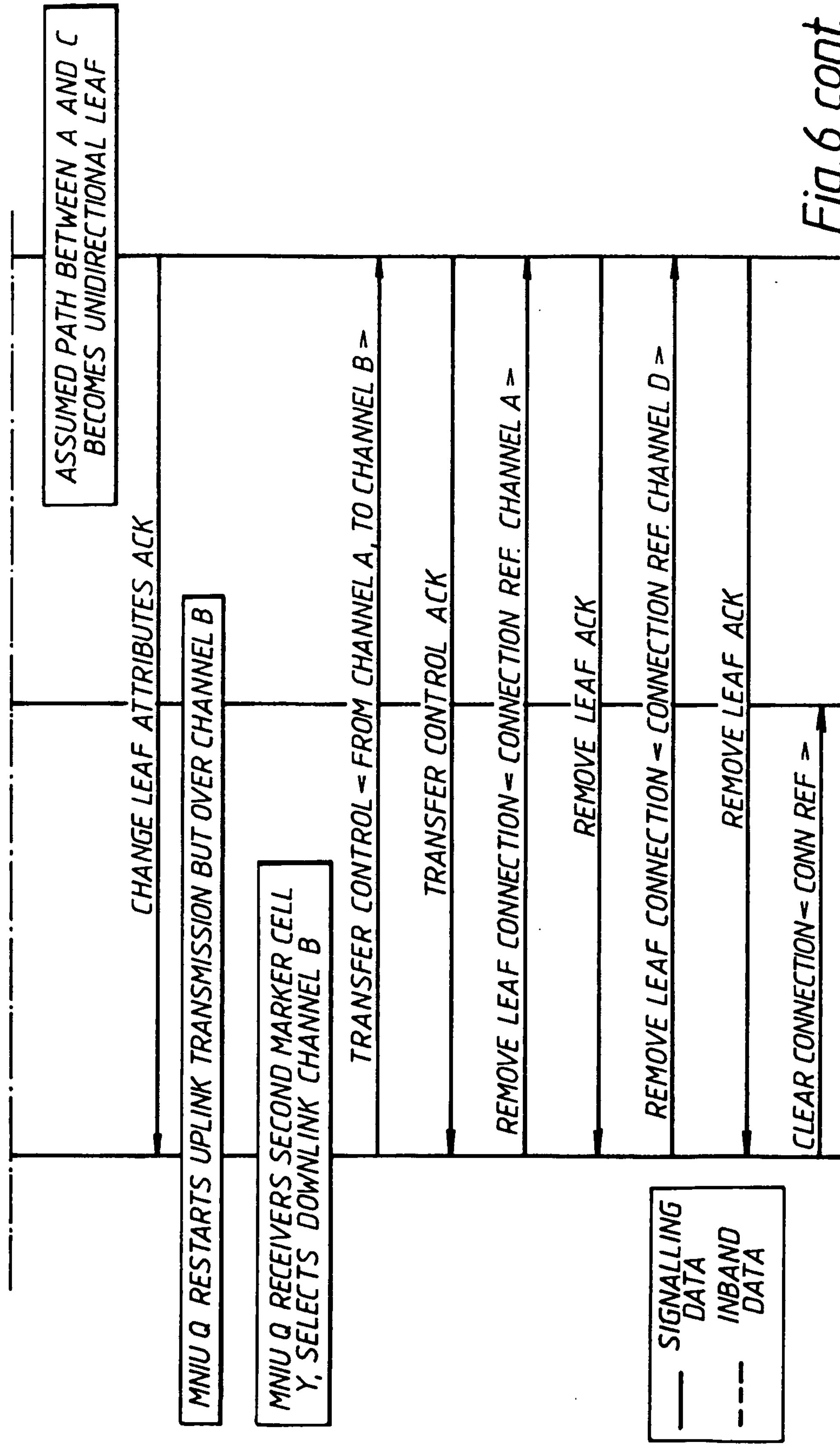
ASSUMED PATH BETWEEN A AND C BECOMES UNIDIRECTIONAL LEAF
CHANGE LEAF ATTRIBUTES ACK
MNIU Q RESTARTS UPLINK TRANSMISSION BUT OVER CHANNEL B
MNIU Q RECEIVERS SECOND MARKER CELL Y, SELECTS DOWNLINK CHANNEL B
TRANSFER CONTROL < FROM CHANNEL A, TO CHANNEL B >
TRANSFER CONTROL ACK
REMOVE LEAF CONNECTION < CONNECTION REF. CHANNEL A >
REMOVE LEAF ACK
REMOVE LEAF CONNECTION < CONNECTION REF. CHANNEL D >
REMOVE LEAF ACK
CLEAR CONNECTION < CONN REF >
SIGNALLING DATA
INBAND DATA

Fig.6 cont.

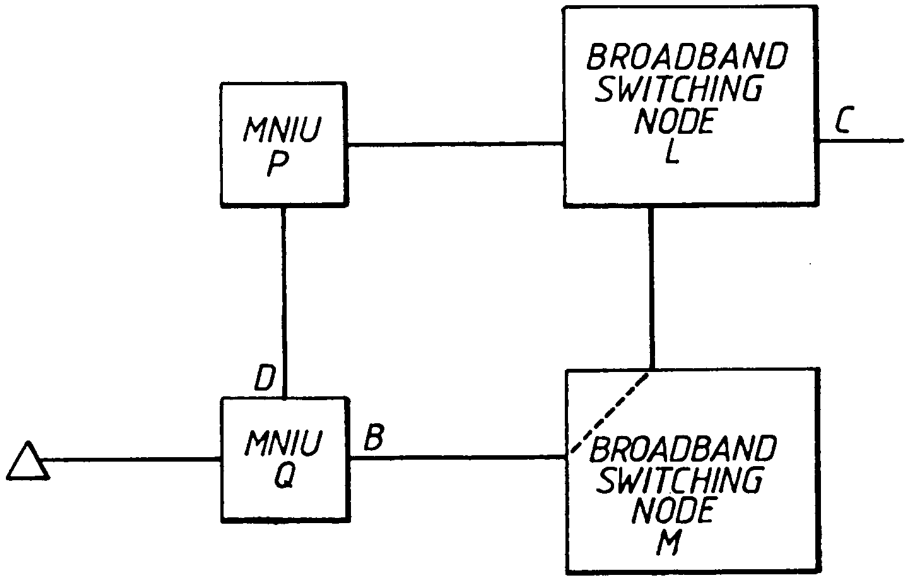
MNIU
P
BROADBAND
SWITCHING
NODE
L
C
D
MNIU
Q
B
BROADBAND
SWITCHING
NODE
M

Fig. 7

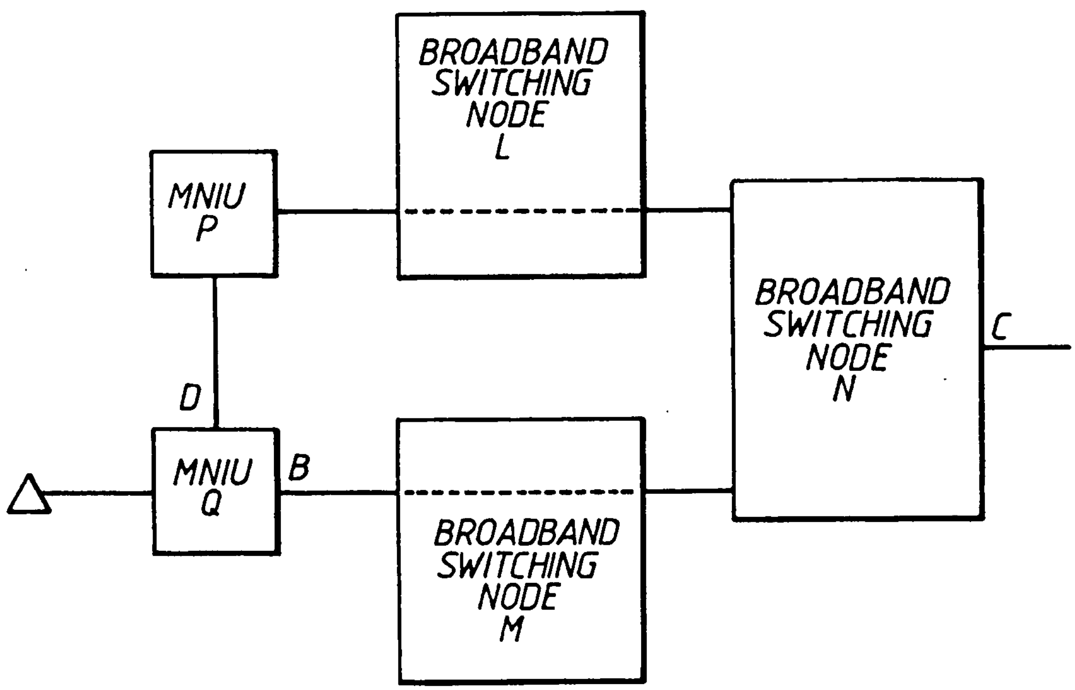
BROADBAND
SWITCHING
NODE
L
MNIU
P
BROADBAND
SWITCHING
NODE
N
C
D
MNIU
Q
B
BROADBAND
SWITCHING
NODE
M

Fig. 8